A COMPARISON OF NUTRIENTS IN LEAVES AND LITTER OF RED, SILVER AND MOUNTAIN BEECH

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ABSTRACT

A nutrient analysis was carried out of leaves and litter of *Nothofagus fusca* (red beech), *N. menziesii* (silver beech), and *N. solandri* var. *cliffortioides* (mountain beech). The nutrients assayed were nitrogen, potassium, sodium, magnesium and calcium.

Although the small number of replicates did not allow statistical validation of the results, some trends could be seen. In general *Nothofagus fusca* had a higher mineral content, and *N. solandri* var. *cliffortioides* a lower nutrient content, than *N. menziesii*.

Within a species, nutrient loss during leaf fall and decomposition, as a percentage of dry weight, varied between nutrients according to their solubility and their use by micro-organisms. Potassium, which is quite soluble, was lost rapidly, whereas calcium and magnesium, which are less soluble, were lost slowly. Sodium was always at a low level. Nitrogen initially was lost very rapidly but rose in concentration in later stages of decomposition. This was attributed to its incorporation into micro-organisms and humic structures.

INTRODUCTION

In this study, nutrient analysis of living leaves, newly fallen leaves, and material from the litter (L), fermenting (F) and humifying (H) layers of the organic horizon of the soil were used to compare the beech species, red beech (*Nothofagus fusca*), silver beech (*N. menziesii*) and mountain beech (*N. solandri* var. *cliffortioides*; hereafter called *N. cliffortioides*). Changes in nutrient concentration during decomposition of beech tree litter were also investigated.

Nutrients assayed were nitrogen, calcium, magnesium, sodium and potassium.

SITE

The forested area chosen for study is on the Lewis Pass (N.Z.M.S. S46 814 961). Here *Nothofagus fusca, N. menziesii* and *N. cliffortioides* form mixed stands. Individual sites were selected where the trees in a small area (ca 5 m^2) were mainly of one species, although not exclusively so, especially in the case of *N. menziesii*. Nine sites, three for each species, were chosen within the area (ca 100 m^2). There is a change in habitat conditions from the forest fringe where most of the *N. cliffortioides* was sampled, to the midst of the forest where *N. menziesii* and *N. fusca* were sampled. The forest fringe has an old, poorly drained and presumably relatively infertile soil.

In the forest some soils of intermediate age are present where *N. menziesii* is common and finally, where *N. fusca* dominates, the soil is very young, well drained and presumably relatively fertile. The youth of the soil is due to deposition of gravel and silt by a small stream.

MATERIALS AND METHODS

In late February, a galvanised 0.305 m^2 tray was placed on the forest floor on each site. One month later the sites were revisited. The litter fallen into each tray was collected. Samples were also collected from the tree at crown height, at 5 m above ground, and from the L, F and H layers of the organic horizon.

Samples were collected with minimal handling, using rubber gloves to avoid contamination, especially of sodium. All the samples were oven dried at 60°C, sealed in 100 ml conical flasks and stored in a cold room. The trapped leaf samples of *N. fusca* and *N. cliffortioides* were relatively pure, but each of the *N. menziesii* trapped leaf samples were about 50% *N. menziesii*, the other 50% being either mainly *N. fusca* or mainly *N. cliffortioides*. It was assumed, when sampling at each site, that the species ratio of the trapped leaf sample was representative of the material in the layers beneath. Fungal mats were observed in most of the F and H layers and the surfaces of the trapped leaves were darkened by oxidation or microbial action.

ANALYTICAL METHOD

To assay for total nitrogen content the Kjeldahl method was used. For potassium, magnesium, sodium and calcium, the oven-dried plant material samples were ashed, dissolved in acid, and assayed using a Techtron 4 spectrophotometer. Calcium was detected by flame emission, and magnesium, sodium and potassium were detected by atomic absorption (Allan 1970, Allan and Parkinson 1969, Metson 1972).

RESULTS

The individual sample values obtained for each nutrient in the leaves and decaying litter of *Nothofagus fusca, N. menziesii* and *N. cliffortioides*, are shown in Figs 1-5.

DISCUSSION

COMPARISON OF NUTRIENT VALUES BETWEEN SPECIES

Generally the individual results show that *N. fusca* tends to have the highest nutrient content and *N. cliffortioides* the lowest content. *N. menziesii* tends to have intermediate values. The exception to this generalization is nitrogen for which *N. menziesii* has the highest concentration, followed by *N. fusca* and *N. cliffortioides*. A relatively higher nutrient content in *N. fusca* could be due to unavoidable microvariation within the general site but it is likely to reflect the normal condition. *N. fusca* often inhabits younger, relatively fertile soils.

COMPARISON OF NUTRIENT VALUES WITHIN A SPECIES

Within a species the nutrient concentration changes during decomposition vary according to each individual nutrient. The more labile minerals can be quickly lost from the system, whereas any tightly bound material is further concentrated and may ultimately be complexed into the humus. Microflora associated with the layers of the organic horizon were unavoidably analysed.

Potassium, which is a relatively soluble mineral, is quickly lost from the system (Fig. 1).

Sodium is present at a very low concentration which is difficult to analyse but it is believed that levels remain fairly constant (Fig. 2).

Although soluble, magnesium may be sometimes tightly bound, e.g., in chlorophyll. The results show a fairly constant slow decrease in concentration, which levels off in the last stage of decomposition (Fig. 3).

Calcium ions are not transported in the phloem so that calcium is not resorbed into the plant before leaf fall (Sutcliffe 1962). Falling litter contains relatively stable calcium, e.g., in cell wall pectates, which is not lost initially in the decomposition process but which is solubilised later by acids formed from other decomposing material, and consequently released. This could explain why the values for calcium (Fig. 4) increase in concentration up to and including the fermentation stage of decomposition before decreasing at the humifying stage.

It has been shown (Phillips and Wareing 1970) that most of the protein, which is the main organic nitrogen-containing material, is broken down and the nitrogen resorbed into the plant or lost during senescence. This is indeed evident from the experimental results (Fig. 5). Several causes of the subsequent rise in nitrogen concentration are suggested.

In any litter with a low C:N ratio (highly probable with a 1% N content), any free nitrogen is likely to be immobilised by the microflora present. They have a C:N ratio in their cells of approximately 10:1-6:1, which is much higher than for normal plant litter material (ca 30:1). Thus, in many cases, actinomycetes, fungi and bacteria decomposing nitrogenous material are actually retaining much of the nitrogen within their own structure and other micro-organisms are utilising the remainder. Fungi in particular are important in this respect, as, relative to other micro-organisms, they have a high nitrogen content. They are well known as colonisers of acid soil and this is substantiated by the observation of hyphal mats in the F and H layers of the beech forest organic horizons both at this site and elsewhere.

Apart from the retention of released nitrogen by immobilization by the microflora, undecomposed protein often complexes with lignin to form stable humic substances which retain and concentrate nitrogen within the humus layer of the organic horizon (Russell 1961).

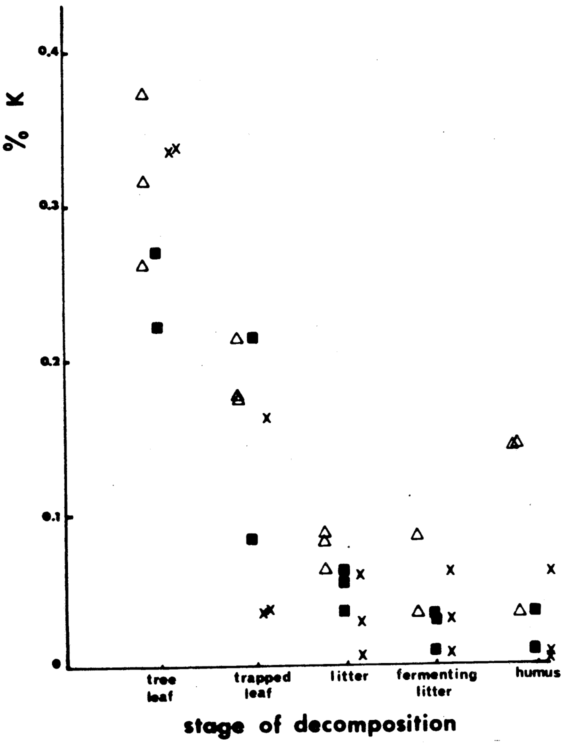

Fig. 1. Potassium.

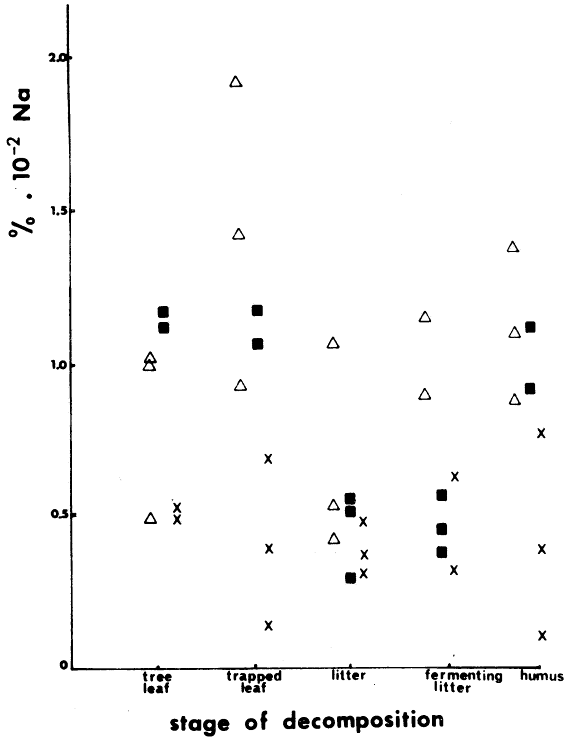

Fig. 2. Sodium.

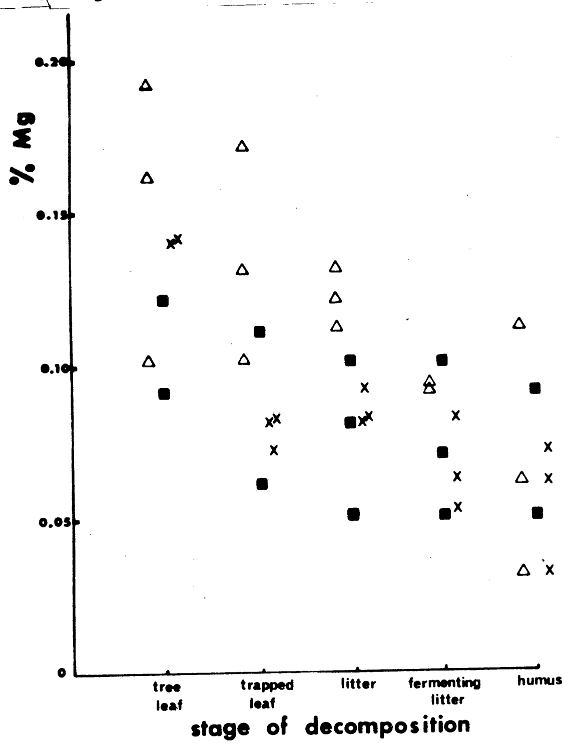

Fig. 3. Magnesium.

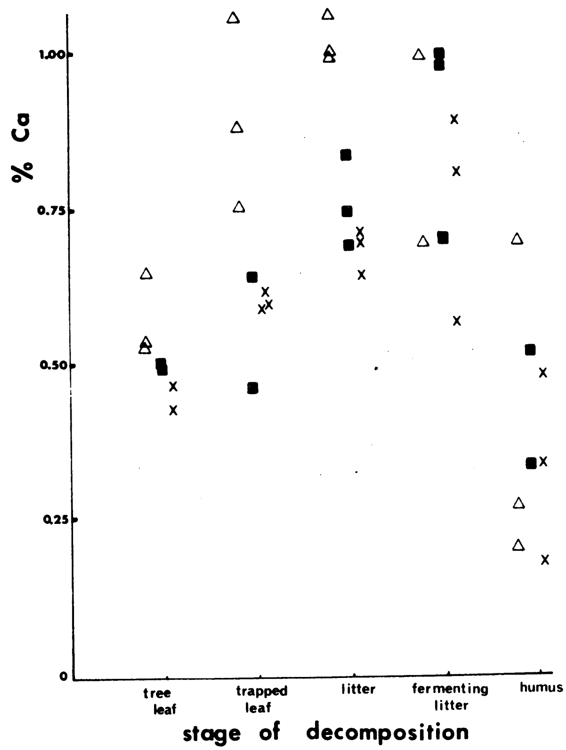

Fig. 4. Calcium.

KEY TO FIGS 1-5

△ Nothofagus fusca

■ Nothofagus menziesii

x Nothofagus cliffortioides

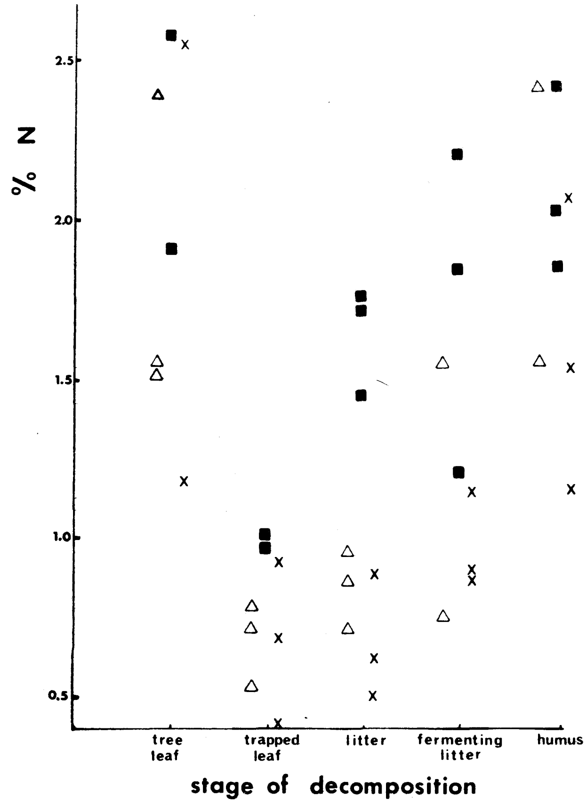

Fig. 5. Nitrogen.

Figs. 1-5 show the values for each nutrient as a percentage of dry weight in each sample of leaves and decaying litter of Nothofagus fusca, N. menziesii and N. cliffortioides. Three samples of each species are shown for each stage of decomposition.

COMPARISON WITH OTHER STUDIES

Work on other *Nothofagus* species has been carried out on the New Zealand species *N. truncata* (Miller and Hurst 1957, Miller 1963a, b, c), and on a South American species *N. obliqua* (Ovington 1954, 1958).

The values and change in content which they measured are similar to those found in the present study with regard to nitrogen, potassium and calcium. All species have a very similar magnesium content in the leaves and fresh litter. However Miller found no loss, and Ovington found a slight increase in magnesium content in subsequent stages of decomposition. In *N. truncata* the sodium content decreases with increase in decomposition, whereas the other species have a much lower constant sodium content. Miller attributed such differences, in part, to a high atmospheric salt content and severe storms during sampling periods.

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